

To: Erik Frisch - City of Rochester; Rochester Bicycle Boulevard Steering Committee
From: Mike Tresidder and Lindsay Zefting, PE - Alta Planning + Design
Date: January 22nd, 2014
Re: Task 2A Bicycle Boulevard Best Practices Memo

1.1 Introduction

In an effort to appeal to a greater number of bicyclists and those interested in bicycling more often, Rochester is pursuing the development of a Bicycle Boulevard network. Bicycle Boulevards (also known Neighborhood Bikeways or Neighborhood Greenways), are low stress, active transportation corridors that have been optimized for bicycle and pedestrian travel. These corridors take advantage of the existing low speed and low volume local street network with enhanced crossings where routes cross major roadways. Bicycle Boulevards have been shown to appeal to the widest range of bicycle users.

This technical memorandum makes recommendations for network routing and public outreach, and discusses potential tools for improving bicyclist safety and comfort on Bicycle Boulevards.



1.2 Benefits of Bicycle Boulevards

There are numerous benefits to bicycle boulevards, including:

- Good for all ages, all abilities - Many bicyclists, or people interested in bicycling, are not comfortable riding in bike lanes on major roads
- Lower speeds and traffic volumes - More comfortable, attractive facility due to fewer interactions with motor vehicles and lower overall traffic speeds
- Connects to destinations - Connect cyclists to key destinations while reducing the amount of time spent in on-street bikeways on major roads
- Great “bang for the buck” - Jurisdictions like them because they take advantage of existing facilities (local roads) and provide a low cost alternative to other types of bicycle accommodations.
- “Quiet” street environment - Create a slower and quieter street environment for adjacent residents. There is a demonstrated preference in the real estate market for homes adjacent to a bicycle boulevard

1.3 Bicycle Boulevard Routing

Based on current best practices for the routing of bicycle boulevards, the following section strategizes potential route development tools and criteria.

1.3.1 Bicycle Boulevard Routing Best Practices

Planning an effective bicycle boulevard network requires foresight and creative problem solving. In general, a successful Bicycle boulevard network:

- Is logical and devoid of excessive out-of-direction travel
- Avoids higher speed and volume roads wherever possible. Where jogs in the route require riding on higher order streets protected bikeway facilities should be considered.
- Connects people to the places they want to access (e.g. libraries, schools, parks, cultural centers, etc.)
- Connects to existing on-street and off-street bikeways. Good Bicycle boulevards complement, and provide a seamless connection to, these facilities. This helps to improve the overall usability of the bikeway network for transportation purposes.
- Helps accomplish a density of bikeway facilities that are spaced approximately every ¼- to ½-mile

Based on these best practices, the following strategy is recommended for identifying a bicycle boulevard network in Rochester.

Collect Data

Bikeway Network

Identifying a possible network begins with good data. Having a good understanding of the planned and implemented bikeway facilities helps isolate areas where connections can be made.

Attractors/Destinations

A good bikeway network connects people to the places they want to go. Having a good understanding of the various attractors, such as schools, parks, commercial centers, libraries, etc. will help planners identify those popular destinations that are, and are not, currently being served by the bikeway network.

Roadway Speeds and Volumes

The City regularly collects motor vehicle traffic speed and volume data. This information can be used to isolate roadways that meet the City-established thresholds for bicycle boulevards. The threshold is typically volumes less than 3,000 vpd and speeds of 25 mph or less. A threshold for the City of Rochester will be determined during the course of the project.

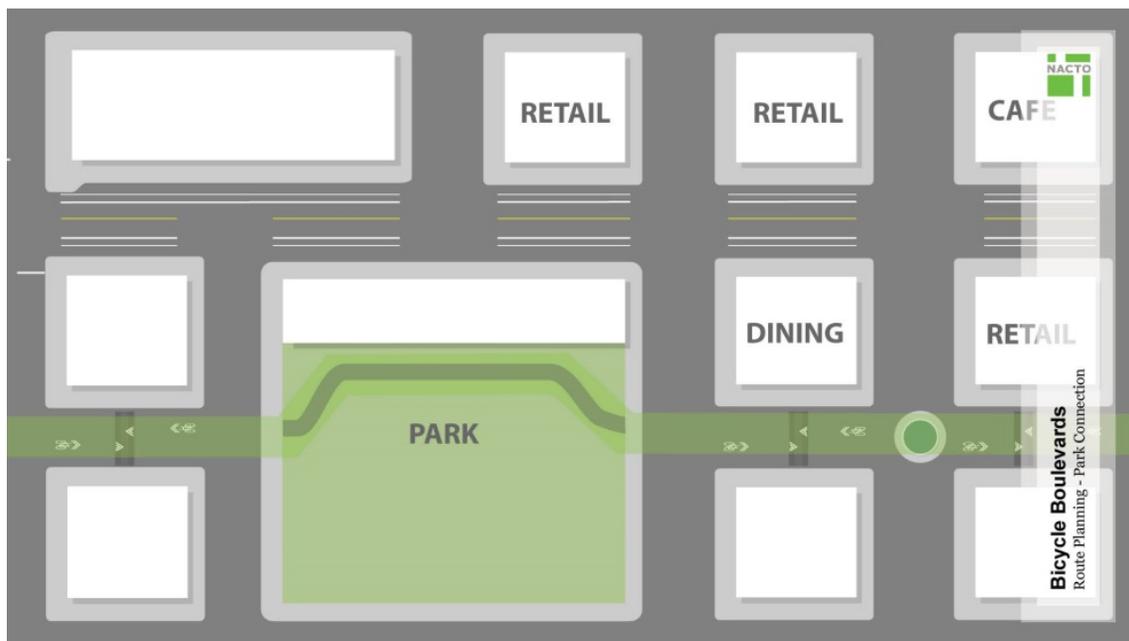


Figure 1. Bicycle boulevard routes should take advantage of existing facilities and connect individuals to key destinations (Source: NACTO Urban Bikeway Design Guide)

Identify Opportunities to Connect Existing/Planned Bikeway Facilities

The bicycle boulevard network has the potential to complement and seamlessly connect with the existing on- and off-street bikeway network. When planning the bicycle boulevard network every effort should be made to take advantage of existing facilities to connect users with key destinations.

Visually Identify Network Gaps

There can be many different kinds of “gaps” in a bikeway network. In general, gaps can be classified in one of six ways:

- **Spot gaps:** point locations lacking active transportation facilities or with an observed / documented safety issue e.g. missing crosswalks, bike lane “drops”, etc.

- **Connection gaps:** missing segments (typically less than ¼-mile long) between routes or connecting to land uses.
- **Lineal gaps:** missing segments or barriers along an otherwise well connected corridor, e.g. bike lanes “dropping” for several blocks or a missing bridge crossing along a trail.
- **Corridor gaps:** missing links longer than one mile that can encompass an entire street where facilities are desired but do not currently exist.
- **System gaps:** larger geographic areas (e.g., a neighborhood or business district) where few or no bikeways exist.
- **Facility quality gaps:** In some cases, a formalized bikeway itself may represent a gap despite its status as part of a designated network. This condition typically occurs when a corridor (often a major street) lacks the type of bicycle facilities to comfortably accommodate a broader user base, including infrequent or less confident cyclists. Other examples include roadway corridors lacking formalized facilities (e.g., bike lanes) where conditions such as higher vehicle speeds and volumes would otherwise justify greater separation between motorists and cyclists.

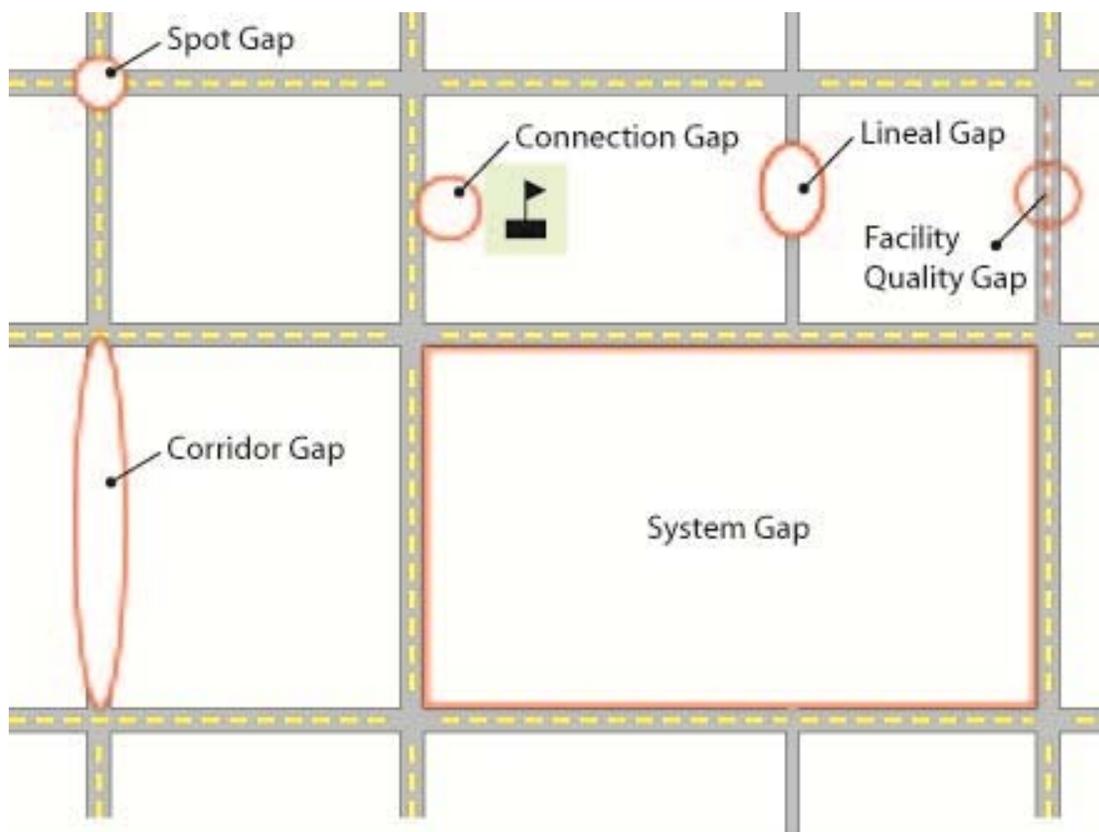


Figure 2. There are several different categories of "gaps" in the bikeway network

Other Considerations

Emergency Vehicle Access

Concerns about a negative impact on response time as a result of bicycle boulevard treatment may crop up. Steps should be taken early in the planning process to involve emergency services, so as not to create adverse impacts to their operations.

Impact to Travel Patterns

Motorists' route preferences often change following a bicycle boulevard installation. Traffic engineers should examine and account for the potential for increased traffic on parallel routes to the bicycle boulevard as a result of its development.

1.4 Design Strategy

Jurisdictions throughout the country use a wide variety of strategies to determine where specific treatments are applied. While no federal guidelines exist, several best practices have emerged for the development of bicycle boulevards. At a minimum, bicycle boulevards should include distinctive pavement markings and wayfinding signs. They can also use combinations of traffic calming, traffic diversion, and intersection treatments to improve the bicycling environment. The appropriate level of treatment to apply is dependent on roadway conditions, particularly motor vehicle speeds and volumes. Traffic conditions on bicycle boulevards should be monitored to provide guidance on when and where treatments should be implemented. When motor vehicle speeds and volumes or bicyclist delay exceed the preferred limits, additional treatments should be considered for the bicycle boulevard.

1.5 Bicycle Boulevard Tools

The following section provides a discussion of potential Bicycle boulevard tools, organized into three key elements to a successful bicycle boulevard:

1. Effective Wayfinding through Signs + Pavement Markings
2. Speed and Volume Management
3. Intersection Design + Management

Signs and Pavement Markings

Signs and pavement markings comprise the basic elements of a bicycle boulevard. These elements differentiate the facility from other local streets and identify the bicycle boulevard as a shared street that has been optimized for bicycle and pedestrian travel. The treatments included in this category are discussed below.

Warning Signage	
<p>Discussion: Warning signage alerts motorists to the presence of bicyclists on a Bicycle boulevard. Signage is especially important near high bike use areas (e.g., schools).</p>	<div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <p>The standard NYS MUTCD Bicycle Warning Sign combined with the 'In Lane' sign is a popular signage choice</p> </div> </div>
Modified Street Signs	
<p>Discussion: Modified street signs, using a visual cue such as a unique stencil, help users quickly identify the street as a Bicycle boulevard. These signs provide an opportunity to uniquely brand the Bicycle boulevard network. The current MUTCD does not allow for different street sign colors.</p>	<div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <p>Berkeley uses a vivid purple color and bicycle stencil to identify its bicycle boulevards.</p> </div> </div>
Wayfinding Signage	
<p>Discussion: A bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes. The MUTCD provides guidance on the use of signs on bikeways. There are three general types of wayfinding signs:</p> <p><i>Confirmation Signs</i></p> <ul style="list-style-type: none"> • Indicate to bicyclists that they are on a designated bikeway. Make motorists aware of the bicycle route. • Can include destinations and distance/time. Do not include arrows. 	<div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <p>This is the standard confirmation sign and adheres to the MUTCD</p> </div> </div>

Turn Signs

- Indicate where a bikeway turns from one street onto another street. Can be used with pavement markings.
- Include destinations and arrows.

Decisions Signs

- Mark the junction of two or more bikeways.
- Inform bicyclists of the designated bike route to access key destinations.
- Provides information about destinations with arrows, distances and travel times.



A turn sign is added to a confirmation sign to identify a change in the direction of the bike route.



This bicycle wayfinding sign, on a Neighborhood Greenway in Portland, OR, adheres to the design specified in the Oregon MUTCD

Pavement Markings

Discussion: Pavement markings increase visibility of Bicycle boulevards and reinforce that cyclists are on a bicycle facility. The pavement markings also help direct riders through jogs in the route. Pavement markings vary widely by jurisdiction. Some communities develop unique, custom markings to reinforce the branding of the bicycle boulevard network.



Bicycle boulevard pavement markings are an opportunity to develop unique branding with wayfinding

Shared Lane Markings (SLMs)

Discussion: SLMs used on bicycle boulevards should be applied using the same basic principles as any other street. The center of the marking should be a minimum of 4' from the pavement edge, or parking lane (if present). However, placing SLM in the center of the travel lane increases the life of the markings because there is less tire wear from motorists.



Shared lane markings in the middle of the travel path increases the longevity of the markings

Speed and Volume Management

Creating a bicycle boulevard environment that is comfortable for bicyclists of all ages and skill levels requires minimizing the impact of motor vehicle speeds and volumes.

Vehicle Speed Impact on Interactions

When reviewing and establishing the appropriate thresholds for vehicle speeds and volumes on a bicycle boulevard, it is important to consider how these impact the number of interactions between bicyclists and motor vehicles. The chart below shows how many vehicles pass an average bicyclist (travel speed = 12 mph), depending on the posted speed and average daily traffic (ADT). At the extremes, a bicyclist on a bicycle boulevard at 1000ADT/20 mph is passed by a vehicle every 90 seconds. That same bicyclist on a bicycle boulevard at 5000 ADT/30 mph is passed by a vehicle every 10 seconds. That is 9 times as many interactions between bicyclists and motor vehicles on the higher volume/higher speed road.

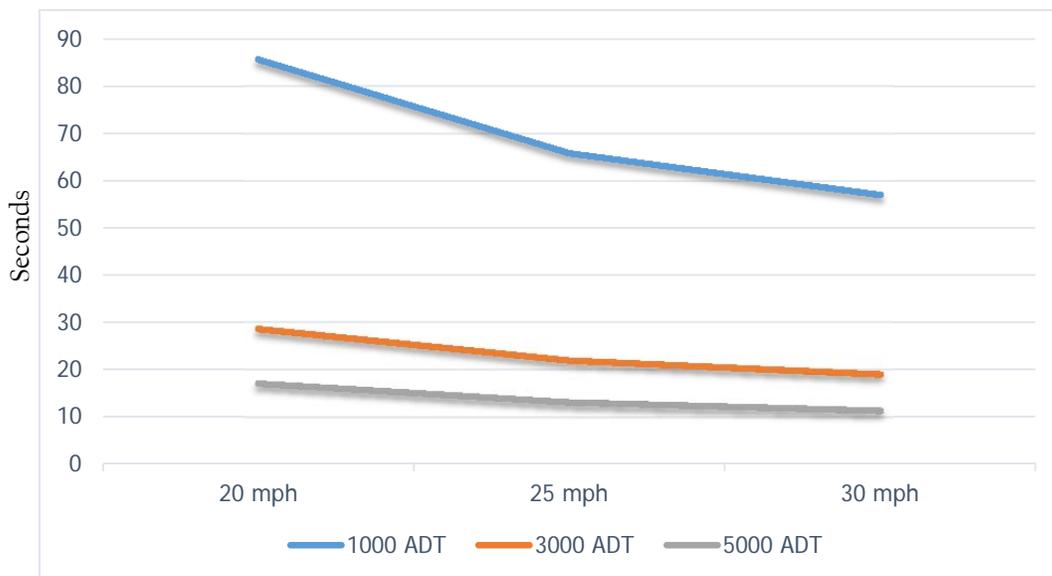


Figure 3. Frequency Bicyclists are passed by Motor Vehicles

- *Assumptions:*
- *Local street peak hour is 15 percent of ADT.*
- *70 percent of peak hour traffic is in one directional*
- *Cars are evenly spaced along the street: no platooning.*
- *Cars are travelling the posted speed limit (speed management techniques may be necessary)*
- *Note: Cars may pass bicyclists more or less frequently depending on how well these assumptions reflect reality.*

Strategies for Reducing Speed

A good rule of thumb is to design bicycle boulevards in a manner that causes the speed differential between motorists and bicyclists to be as small as possible. The closer that the operating speeds of bicyclists is to moving vehicle traffic the more comfortable it is for bicyclists. A small speed differential also has the added benefit of improving motorist’s reaction time, thereby decreasing the chances of a crash involving a bicyclists and motorists and reducing the chance of injury should a crash occur. Treatments to reduce speed are discussed in further detail below.

Reduced Speed Limits	
<p>Discussion: Reduced speed limits are one of the more straightforward speed reduction strategies. Lowering speed limits from 30 to 25, or from 25 to 20 can make a significant improvement for conditions along bicycle boulevards. Slower travel speeds don’t just benefit bicyclists either, they improve conditions for residents, walkers, joggers, and other street users too. Lower vehicle travel speeds and volumes are also known to help reduce traffic injuries, and 20 mph is widely considered as a dividing line between pedestrian injury and fatality.¹ Reducing the City speed limit would require an act of the state legislature.</p>	 <p>20 mph speed limits on bicycle boulevard help to keep the speed differential between motorists and bicyclists low</p>

Horizontal and Vertical Deflection

Horizontal traffic calming devices cause drivers to slow down by constricting the roadway space or by requiring careful maneuvering. Vertical speed control measures are composed of slight rises in the pavement, which cause motorists and bicyclists to slow down to travel over.

Curb Extensions	
<p>Discussion: Curb extensions, placed on both sides of the street, narrow the travel lane and encourage all road users to slow down. When placed at intersections, they reduce the crossing distance for pedestrians and increase visibility of individuals crossing the street. They reduce curb radii and further lower motor vehicle speeds.</p>	 <p>Curb extensions are also an opportunity to beautify the street with attractive landscaping</p>

¹ US Department of Transportation, National Highway Traffic Safety Administration. *Literature Review on Vehicle Travel Speeds and Pedestrian Injuries*, DOT HS809 021 October 1999.

Mini Traffic Circles

Discussion: Mini traffic circles are a type of horizontal traffic calming that can be used at minor street intersections. Traffic circles reduce conflict potential and severity while providing traffic calming to the corridor. Design, including landscaping, should allow for adequate sight distance.



Mini traffic circles are also an opportunity to beautify the street with attractive landscaping

Speed Cushions

Discussion: Speed cushions are used to decrease motor vehicle speeds on local roads. They are raised areas, usually placed in a series across both travel lanes. In contrast to a typical speed hump, the gaps with speed cushions accommodate the wheel tracks of emergency vehicles.



Some jurisdictions prefer the use of speed cushions over traditional speed humps

Narrow Streets

Discussion: Physically narrowing the street, with or without the presence of parking, helps to reduce motor vehicle speeds. Narrow streets may require approval through the land use process.



Some jurisdictions have standards to accommodate narrow streets

Strategies for Reducing Volume

Maintaining motor vehicle volumes below 3,000 vehicles per day (vpd), where 1,000 - 1,500 vpd is preferred, significantly improves bicyclists' comfort. To manage volume, physical or operational measures can be taken on routes that have been identified as a bicycle boulevard. If volumes less than 3,000 vpd are not possible for a short segment of the bicycle boulevard, then a protected on-street bikeway, such as a cycle track, should be considered. These volume management elements also provide an opportunity for landscaping, stormwater management, and other pedestrian and bicycle supportive amenities.

Traffic Restriction Signage	
<p>Discussion: The most straightforward traffic volume reduction strategy is signage restricting motor vehicle through movement. However, if signage is not combined with more intensive traffic calming it is not very effective, due to low compliance. The curb extension pictured here reduces the chance of right turns from the through roadway.</p>	 <p>Traffic restriction signage is a low cost treatment for reducing motor vehicle volumes</p>
Choker Entrances	
<p>Discussion: Choker entrances are used to reduce motor vehicle volumes by restricting/constraining vehicle passage while allowing full bicycle passage to a boulevard.</p>	 <p>Choker entrances allow motor vehicle access in one direction only, reducing overall volumes</p>

Diagonal Traffic Diverters

Discussion: Diagonal traffic diverters are similar to choker entrances, but they restrict *both* directions of traffic off of the bicycle boulevard by forcing motorists to turn, while allowing pedestrians and bicyclists to continue through a gap in the curb.



Diagonal diverters require motorists to turn at the intersection, but allow bicyclists to travel through

Median Diverters

Discussion: Median diverters restrict through motor vehicle movements while providing a refuge for bicyclists to cross in two stages.



Median diverters restrict motor vehicles from continuing through on a bicycle boulevard

Intersection Design

The level of design emphasis required at intersections along a bicycle boulevard is dependent on whether the intersection occurs at a major or minor street and the complexity of the intersection. These factors dictate the level of treatment that is required to make it safe, convenient, and comfortable for bicyclists. Striking a balance between maximizing bicyclist safety and minimizing bicyclist delay will lead to a successful bicycle boulevard that feels logical and comfortable for all roadway users. To this end, the following diagram from the NACTO Urban Bikeway Design Guide is helpful. This figure clearly illustrates the optimal conditions as intersection complexity increases.

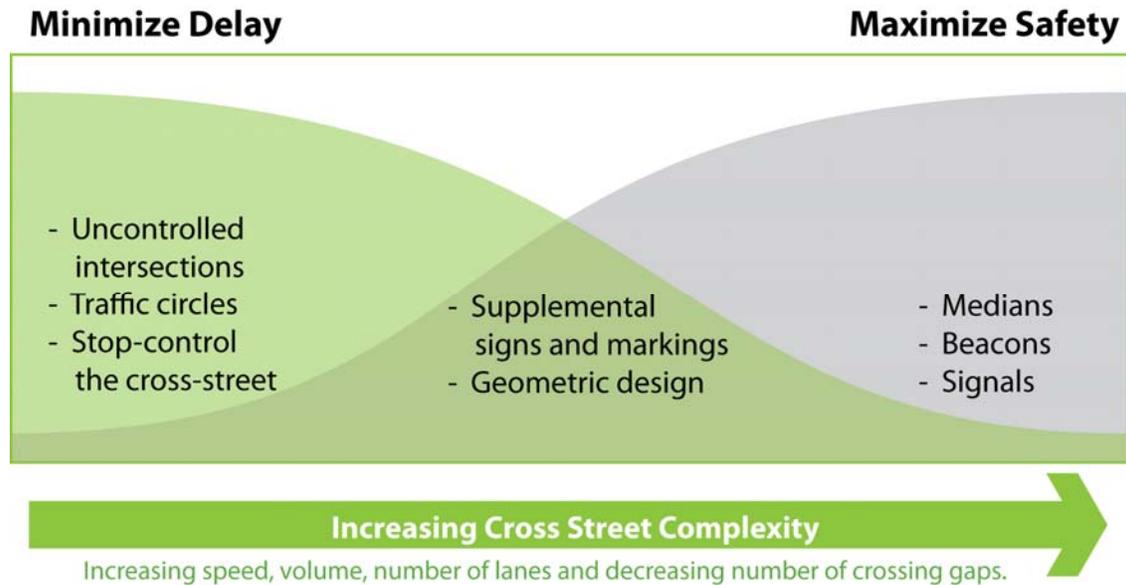


Figure 1. Striking a balance between bicyclist safety and convenience on a Bicycle boulevard is best accomplished by assessing intersection complexity and adjusting the design accordingly (Source: NACTO Urban Bikeway Design Guide)

Minor Street Crossings

Using the guidance from NACTO, intersections with minor streets should be modified to reduce bicyclist delay. This means that, where possible, the user traveling on the bicycle boulevard should be given priority—creating fewer stops for bicyclists. Fewer stops reduce travel time, minimize effort required to get started after stopping, and help improve compliance with traffic control devices. Minor street crossing intersection treatments include:

Stop Sign Placement	
<p>Discussion: Stop signs on bicycle boulevards should be placed on side street approaches in a way that favors through traffic on the bicycle boulevard. This creates fewer stops and starts for bicyclists. This treatment is only appropriate at minor intersections and should be used judiciously. This treatment should also be used in conjunction with traffic calming to discourage an increase in traffic volumes.</p>	 <p>Turning stop signs to prioritize movement on the bicycle boulevard is a low cost way to improve conditions for bicyclists</p>
Mini Traffic Circles	
<p>Discussion: In addition to being a horizontal traffic calming device, mini traffic circles are an intersection treatment. These raised or delineated islands help reduce vehicle turning and through speeds (narrowed travel lanes).</p>	 <p>Mini traffic circles help to minimize bicyclist delay on bicycle boulevards</p>

Major Street Crossings

At intersections with major roadways, safety takes precedence above minimizing delay for bicyclists. There are many different kinds of treatments that help to improve safety at major intersections. There can be significant costs that are associated with additional bike protection. Major street crossing intersection treatments include:

Bicycle Detection at Intersections	
<p>Discussion: Video detection, loop detectors, and activated push buttons are three types of bicycle detection devices for use at intersections. Bicyclist detection at intersections improves safety and compliance with traffic control devices.</p>	 <p>Accompanying signage lets bicyclists know how to signal a green light</p>
Bike Boxes	
<p>Discussion: Bike boxes help increase bicyclist visibility to motorists at intersections. This treatment reduces the danger of right “hooks” by providing a space for bicyclists to wait at signalized intersections.</p> <p>Note: Bike boxes in Portland, OR have led to a higher crash rate (during the ‘stale green’) when installed on downhill grades with high speed bicycle travel (>15 mph).</p>	 <p>Bike boxes can be used in conjunction with a right turn lane</p>

Median Refuge Island

Discussion: Median refuge islands can improve user safety by providing pedestrians and bicyclists space to perform the safe crossing of one side of the street at a time. They also create a visual “pinch point” for approaching motorists, reducing motor vehicle speeds on the approach.



Median refuge islands allow one direction of traffic to be crossed at a time

Mid-block Crossings

Discussion: Mid-block crossings provide a crossing opportunity where there is no intersection. At mid-block locations, crosswalks are marked where there is a demand for crossing, and there are no nearby marked crosswalks.

Tier 1: Crosses a 2-lane street with or without an Island/refuge-install high visibility (curb extensions considered)

Tier 2: Crosses a 3-lane street with island/refuge-install high visibility signs and markings (flashing beacons considered)

Tier 3: Crosses a 3-lane street without island/refuge-- install high visibility signs and markings or pedestrian actuated signal

Tier 4: Crosses a 4-lane or greater street without island/refuge-- install pedestrian actuated signal (pedestrian actuated signal, pedestrian over or undercrossing considered)



The level of design emphasis at mid-block crossing locations depends on the roadway context

Treatments for Route “jogs”

Since bicycle boulevards utilize local streets, they do not always follow a perfectly linear path, especially in the suburban context. These “jogs” in the route can be challenging for Bicycle boulevard users navigating the route.

Bike Left Turn Lanes can be used to help address this issue where bicycle boulevards intersect with streets at off-set locations. However, these treatments involve the bicyclist navigating out into the roadway to wait and turn. This can be uncomfortable for less confident



Bike left turn lanes help bicyclists conveniently navigate jogs in the Bicycle boulevard route

bicyclists.

Two-way Cycletracks with High Visibility Crossings can be used in place of bicycle left turn lanes to create an additional level of separation for Bicycle boulevard users. An example of this treatment is the NE Going St intersection at NE 33rd Ave in Portland, OR.



A grade separated cycle track can help bicyclists comfortably transition through a jog in a Bicycle boulevard

1.6 Marketing and Branding

Public Outreach for bicycle boulevards is three-fold. The first phase occurs during the planning and identification of potential bicycle boulevard routes. The second, and more robust outreach phase, happens when the project is ready for implementation. The final, and optional phase, is the active promotion of the network. The final phase celebrates the success of active travel along bicycle boulevards and is important for establishing the value of these facilities for the community. This section summarizes the experiences of several jurisdictions that have planned and implemented bicycle boulevards.

1.6.1 Best Practices

Public Outreach for Planning the Network

Planning for all bikeways, not just bicycle boulevards, typically takes place during a large bicycle and pedestrian master planning process. Using a variety of media (e.g. project websites, posters/flyers, and email lists), jurisdictions spread the word about upcoming planning events and open houses. In this way, the jurisdiction collects and disseminates public feedback concerning which routes would make acceptable bikeways and which do not. During this stage the public has the opportunity to address concerns about specific routes and the potential impacts of on-street bikeway facilities.

Public Outreach for Implementation

Public outreach at the implementation phase is crucial. Residents are often sensitive to proposed changes in their neighborhood and on their local streets. Reaching out to adjacent property owners early in the process helps to alleviate concerns about traffic impacts, parking issues, and property access before major planning is underway. The bicycle boulevard concept can also be confusing because it is not just any one facility, but a combination of treatments, that together, make the street more comfortable for active transportation. Postcard mailers and flyers that explain the concept of bicycle boulevards and their benefits can help attract support for the project before the first public open house is held. Successful outreach at this stage can include:

- Postcard mailers and/or door hangers at adjacent property owners' homes
- Flyers at schools, parks, farmers markets, and community centers
- Announcements on City, County, or separate project websites
- Community Walk/Bike Audits of the route being considered for bicycle boulevard implementation
- Community workshops

- Neighborhood Association presentations
- Social media announcements
- Public Service Announcement on TV and radio

One new and innovative strategy that is an increasingly popular, involves the use of temporary traffic calming to simulate how the street will function following implementation. By implementing the treatments for a single day, the community has the opportunity to get a feel for the proposed street environment and provide feedback prior to a permanent installation. These temporary installations are sometimes marketed as a street event, complete with food, fun activities, and music. Public comment can be collected onsite and it gives planning/engineering staff an opportunity to explain the design to people that may be unfamiliar with traffic calming treatments.

Public Outreach to Actively Promote the Bicycle Boulevard Network

Calmer, quieter streets are great places for people walking, biking, and skating. The promotion of the bicycle boulevard network as a great place to spend time outdoors being active, is a good way to increase positive sentiment in the community about these facilities. Many jurisdictions host annual events that celebrate walking and biking by completely restricting motor vehicle access on select routes (e.g. Sunday Parkways, Open Streets, Summer Streets, or Play Streets). These events encourage people to get outside, talk with neighbors, walk, bike, and play in a place that is usually reserved for the use of cars. Bicycle boulevards are excellent places to host street events because they are already low traffic and have a strong neighborhood feel. These events help reinforce the value of Bicycle boulevards for the community and can help increase support their development in other areas of the community.

Specific Items to Address with Residents/Property Owners:

Access to Property

Residents may be concerned about how the proposed changes to the street will affect access to their properties. Sometimes the elements that are used on a bicycle boulevard can require residents to change the route they use to access their properties.

Parking Issues

Residents are often very concerned about potential negative impacts to parking. It is important to discuss that bicycle boulevard treatments do not necessarily eliminate or restrict on-street parking. Some treatments, such as curb bump outs or chicanes may replace a few on street parking spaces.